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LAKE ERIE WATERSHED STUDY PLAN

Public Health Service
Chicago, Illinois

March 1963

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LAKE ERIE WATERSHED

STUDY PLAN

PRELIMINARY

March 1963

U. S DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Division of Water Supply and Pollution Control
Great Lakes-Illinois River Basins Project

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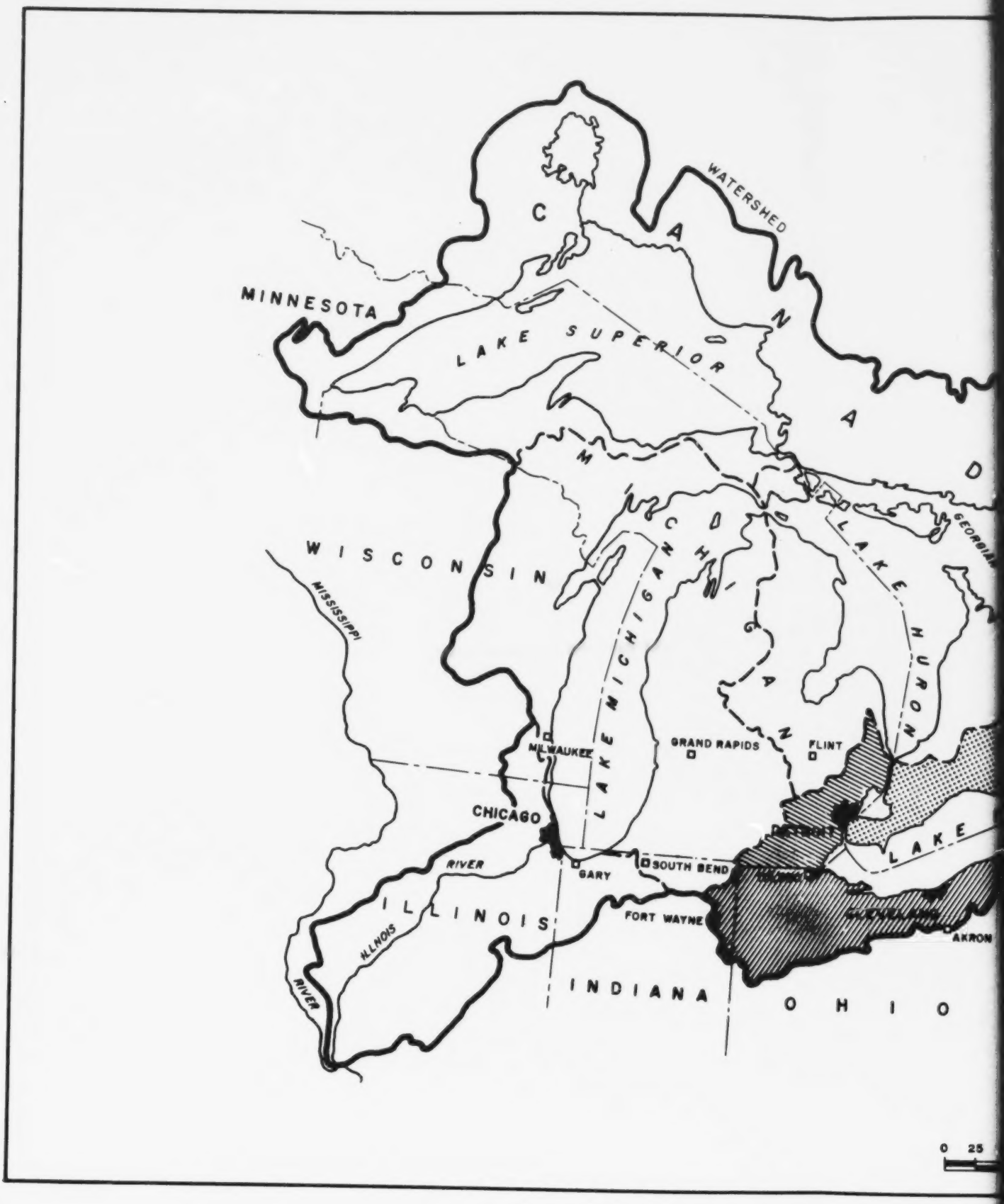
INTRODUCTION

The Department of Health, Education, and Welfare, Public Health Service, Great Lakes-Illinois River Basins Project, in cooperation with State agencies concerned with public health, water pollution control, water resource development, and related fields, and with other Federal and Interstate agencies, is planning to undertake a study of Lake Erie beginning the first quarter of fiscal year 1963. The study will be undertaken as a part of the Public Health Service's activity to develop comprehensive programs for water quality management for interstate waters and tributaries thereof. Similar studies are currently being carried out on the Illinois River and Lake Michigan; future studies are planned for the remaining Great Lakes. See figure No. 1. It is intended that a comprehensive program for water quality management for the entire Great Lakes Basin will be available in 1968.

The study will be undertaken in cooperation with State and local Water Pollution Control agencies, the municipalities and industries in the study area, and with other Federal and Interstate agencies concerned. In the development of the comprehensive plan, due regard will be given to the improvements and water resource management practices which are necessary to conserve the water quality in Lake Erie and tributaries for public water supplies, propagation of fish and wildlife, recreational purposes, agricultural, industrial, and other legitimate uses.

Preliminary studies will begin shortly after August 1, 1962, to be followed by an intensive program of sampling, laboratory analysis and measurement of currents to be undertaken on or about July 1, 1963. The preliminary studies will be limited to a review of prior water quality studies of Lake Erie and tributaries, the development of an inventory of water supplies and sources of waste water, a study of water uses and water resource management practices, preliminary economic and demographic studies, and hyrological and meteorological studies. The Project will rely on contractual services to supplement the activities of the Project in certain fields of study. Plans are to establish a field office in Cleveland shortly after July, 1962, and a field laboratory will be established on or about July 1963 in anticipation of the intensive studies to be undertaken in Lake Erie after July, 1963.


WATERSHED
C A N A D A
MINNESOTA
LAKE SUPERIOR
M I C H I G A N
WISCONSIN
MISSISSIPPI
LAKE MICHIGAN
LAKE HURON
GEORGIAN
MILWAUKEE
GRAND RAPIDS
FLINT
CHICAGO
DETROIT
LAKE
RIVER
GARY
SOUTH BEND
ILLINOIS
FORT WAYNE
AKRON
ILLINOIS
RIVER
INDIANA
O H I O
0 25

Scale in Miles

0 25 50 100 150 200

LEGEND

- Lake Erie Study
- Portion of Lake Erie Study supplied by Detroit Enforcement Study
- Proposed Canadian portion of Lake Erie Study

GREAT LAKES & ILLINOIS RIVER BASINS PROJECT

LAKE ERIE BASIN

DEPT. OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V 2-a CHICAGO, ILLINOIS

FIGURE 1

OBJECTIVES

The objectives of the study are:

1. To determine the present quality of the waters of Lake Erie and its tributaries, by a review of existing records supplemented by a field sampling program.

2. To inventory water uses and trends of usage in the Basin, for municipal and industrial water supply, recreation, aquatic and wildlife, navigation, agriculture, and other purposes.

3. To compile data on sources of pollutional quantities and characteristics of water-borne wastes, in each sub-drainage basin, catalogued by sources and points of discharge.

4. To appraise the adequacy of present practices in land use, water use, and waste disposal in relation to water quality protection.

5. To measure Lake Erie currents and establish their patterns as an aid to predicting the fate of pollutants discharged into the lake and resultant effects on the lake.

6. To make economic and demographic studies leading to projections of future growth, accompanying water demands, and associated water-borne wastes.

7. To determine the existing and potentially developable water resources, ground and surface, within the Basin.

8. To formulate a plan for guidance of a cooperative program aimed at improving and protecting the quality of waters in the Basin. This includes development of agreements on the water quality goals, analysis of measures for achieving these goals, and time tables for their accomplishment.

BASIC DATA COLLECTION

The collection of basic data will be one of the first activities started, and will be a continuing activity. Contacts will be established and maintained with persons and agencies in the area having pertinent information and records. First efforts will be directed toward determining what information is available, the gaps in needed information, and how these gaps may be filled, either by Project investigations or cooperative effort by others. Discussion of specific categories of basic data follows.

Water Uses

The inventory of municipal and industrial water uses in the Lake Erie Basin will be compiled for each sub-drainage basin. The published data will be updated where needed through state office visits for collecting data from unpublished reports.

In addition to the municipal and industrial water uses, data will be collected and analyzed to show all water uses, including agricultural, recreational, fish and aquatic life and wildlife, and other legitimate uses.

All data will be cataloged in appropriate and meaningful units.

Water Borne Wastes

A comprehensive picture of the wastes loadings to receiving waters in the basin will be obtained. The state agencies and other agencies will be asked to cooperate in obtaining the data via state records, plant visits and/or plant sampling at selected plant sites, both industrial and municipal. Where practical, information will be obtained relative to the loadings contributed by shipboard discharges and dredging operations in Lake Erie and tributary streams.

Water Quality Appraisal

Existing reports will be used as a source of data for determining the present water quality and as a guide in determining where stream sampling is needed.

Geology

A geological study of the Basin will supply necessary background material for determining availability of ground water supplies for local communities and industry. Geological publications and available engineering reports are expected to yield valuable data for this purpose.

Hydrology

A water budget study of Lake Erie will be required to determine the effects of the various sources of pollution on the present and future water quality of the lake. This study would include determination of Lake Erie water supply and water loss. Supply includes rainfall, inflow from Lake Huron, inflows from tributary streams, and groundwater inflow. Outflow includes evaporation and outflow to Lake Ontario. The determination of evaporation may require collection and analysis of considerable meteorological data.

Low-flow frequency studies will be required on tributary streams to determine flows available for water supply and quality control purposes. This would include a survey of past data with appropriate projections to cover the circumstances found in the study. Sources utilized would include published Weather Bureau data, Corps of Engineers and Lake Survey data, and the publications of the U. S. Geological Survey. Flow data from tributary streams may involve, in some instances, the establishment of supplemental stations for stream gaging, probably with the cooperation of the U. S. Geological Survey on a contract basis. Flows from individual industries, treatment plants, and municipal sources or drains should be obtained to complete the flow balance and find what specific contribution is being made to the pollution budget of the stream.

FIELD OPERATIONS

Sampling Program

Field activities will provide for the actual collection of the routine and special samples. This would entail coordinating car routes, industrial outlet sampling, bridge sampling, boat sampling, couriers, transportation of samples and the selection and training of personnel. The scope of the sampling program involves the maintenance and operation of sampling stations at industrial plants, on Lake Erie, and selected tributaries, plus the maintenance and operation of monitoring equipment such as dissolved oxygen analyzers and carbon filter stations.

Industrial Outlets

It is anticipated that the Study Plan will require the sampling of waste water outlets from industrial waste discharges discharging separately to the water courses under study. Sampling at industrial outlets will involve measurements of flow through the use of current meters, weirs, or automatic devices depending upon the amounts of flow, accessibility, etc. Sample collection must be made either in proportion to the flow, or flow data must be secured and submitted along with constant volume samples. This will permit compositing the samples in proportion to flows at sampling time. Industrial waste sampling would include the installation and maintenance of flow gages, weirs, pumps, proportional sampling devices, conductivity and pH measuring equipment, filter installations (industrial), and other sampling and monitoring equipment as required by the waste being sampled.

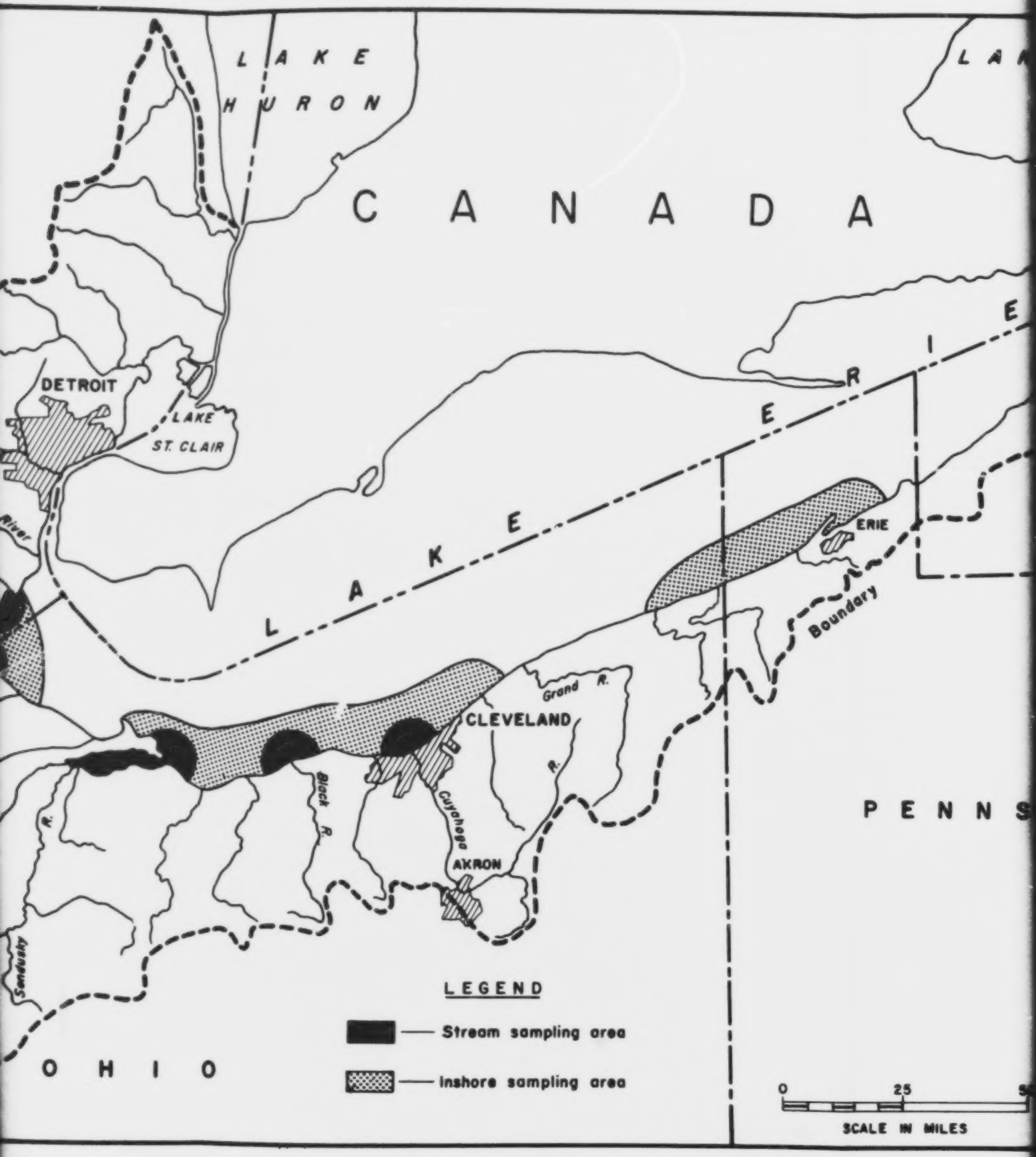
Stream Sampling

Sampling of the major tributaries will be carried out, and limited sampling of the minor tributaries. Figure No. 2 shows the location of proposed major tributaries for sampling to determine their relative importance in the overall water quality picture.

The following are major streams proposed for sampling:

Huron River
Raisin River
Maumee River
Sandusky River
Black River
Cuyahoga River
Cattaraugus Creek
Buffalo River
Niagara River

MICHIGAN
DETROIT
LAKE
ST. CLAIR
Huron
River
Raisin
River
River
TOLEDO
River
INDIANA
St. Joseph
Maumee
FORT
WAYNE
St. Mary's
R.
Sandusky
R.
Watershed
OHIO


LAKE HURON
CANADA
DETROIT
LAKE ST. CLAIR
River
LAKE ERIE
ERIE
Boundary
CLEVELAND
Grand R.
R.
Black R.
Cuyahoga
AKRON
R.
Sandusky
PENNS
OHIO
LEGEND
Stream sampling area
Inshore sampling area
0
25
SCALE IN MILES

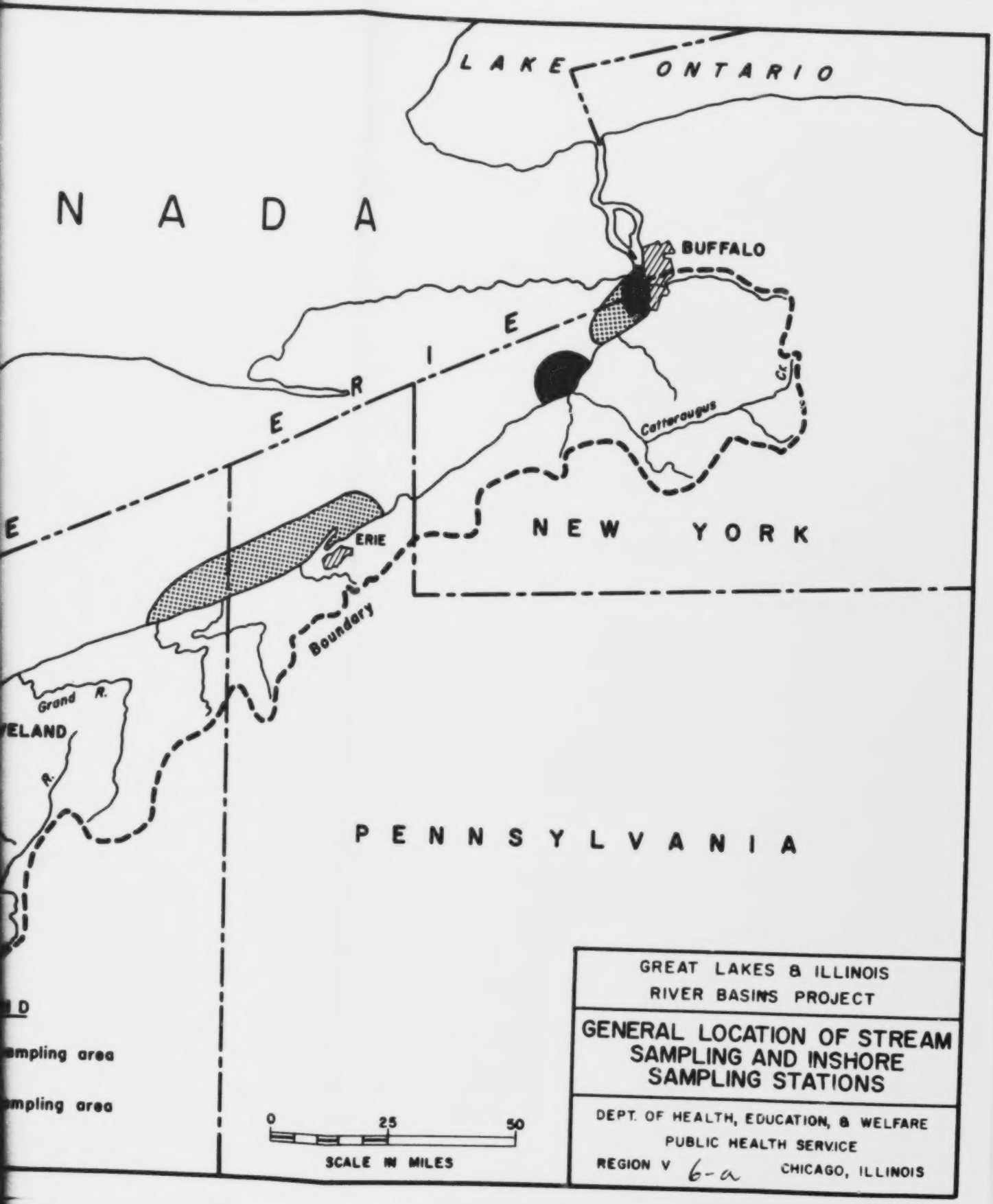

LAKE ONTARIO
NADA
BUFFALO
E
I
R
E
E
Cattaraugus
Cr.
NEW YORK
ERIE
Boundary
Grand R.
ELAND
R.
PENNSYLVANIA
D
mpling area
mpling area
0
25
50
SCALE IN MILES
GREAT LAKES & ILLINOIS
RIVER BASINS PROJECT
GENERAL LOCATION OF STREAM
SAMPLING AND INSHORE
SAMPLING STATIONS
DEPT. OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V 6-a CHICAGO, ILLINOIS

FIGURE 2

Samples will be taken a reasonable distance upstream from the inlet to determine the quality of the tributary and a radial sampling pattern will be conducted at the inlet to define the area of dispersion and degree of dilution. The specific location and exact number of the sampling stations upstream from the mouth will be decided after field reconnaissance studies and review of existing data.

Lake Erie Sampling

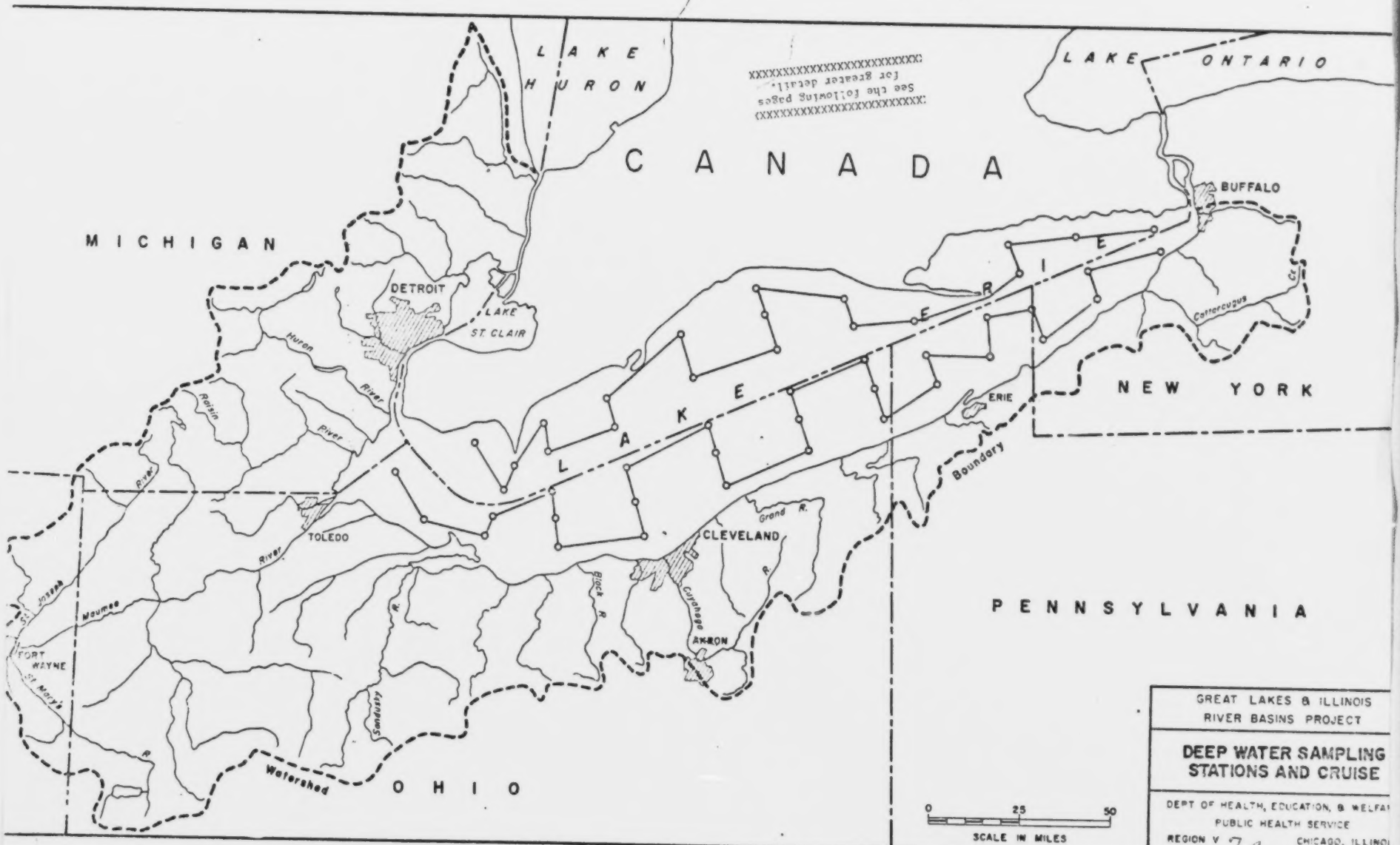
Deep Water. A deep water sampling study will be instituted to determine the water quality of the lake and its variation with depth. The station locations will be the same as that of lake current metering network for the purpose of constructing lake profiles and tracing the pattern of movement of these profiles. Utilization of oceanographic boats will be made when possible. Figure No. 3 shows the proposed cruise for the U. S. waters and its Canadian counterpart.

Inshore. In addition to the radial pattern of sampling where tributaries empty into Lake Erie, samples will be collected from inshore waters within the vicinity of municipalities and other areas discharging large quantities of wastes. See Figure 2. The inshore sampling program will furnish valuable data for determining the effective influence of waste outfalls and tributaries on the lake water quality. This data will also be useful in determining effects of tributary and lake currents in the dilution of wastes and their pattern of travel.

Inshore sampling, as such, may not be necessary in areas where tributary sampling gives the desired information.

Flow Measurements

Flow measurements would be instituted to determine the amount of the flow at any given cross section or range where necessary to implement the field data. The hydrometric data would be drawn largely from the work of a hydraulics unit supplementing published data obtainable from other governmental agencies.



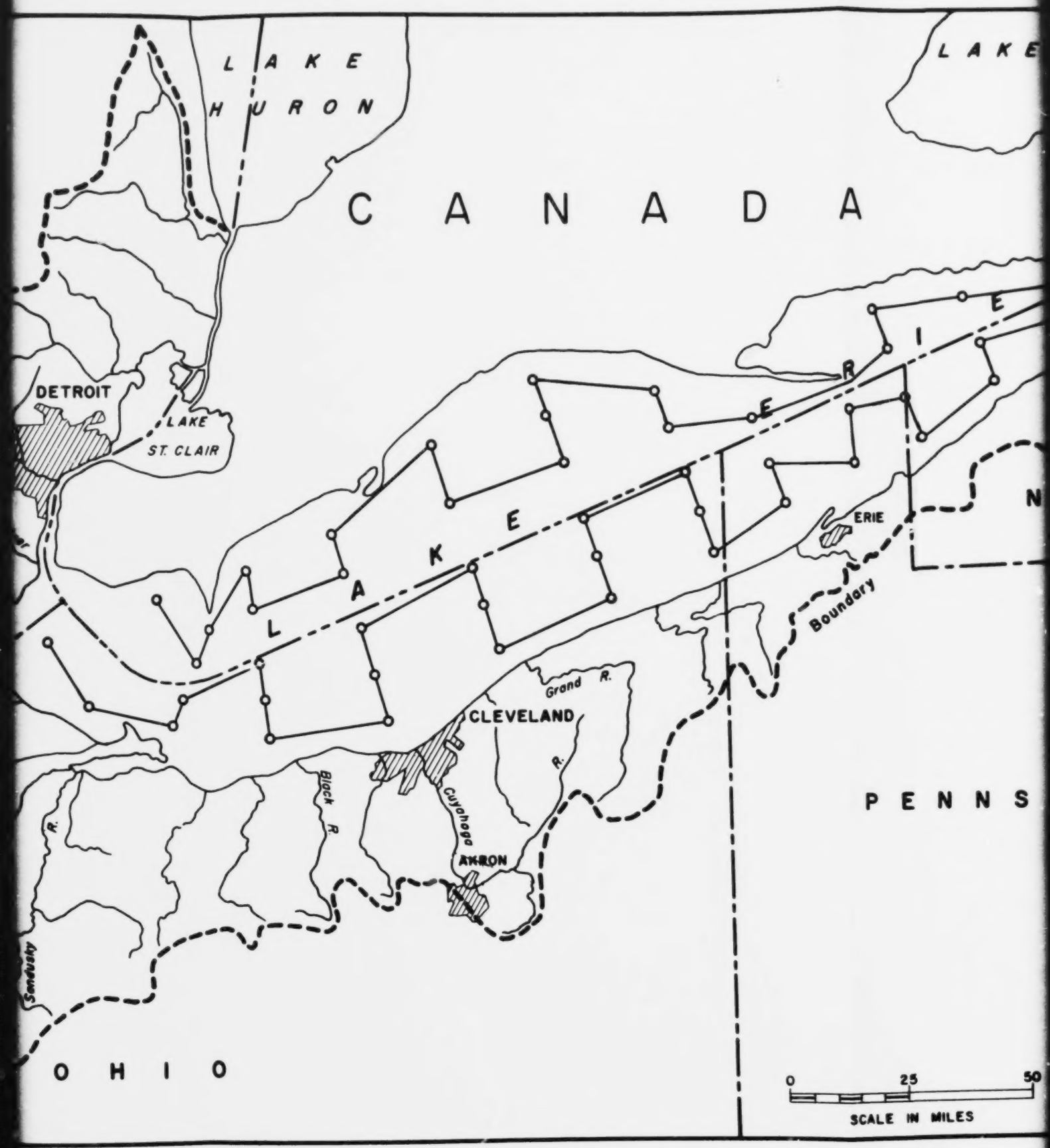
GREAT LAKES & ILLINOIS RIVER BASINS PROJECT

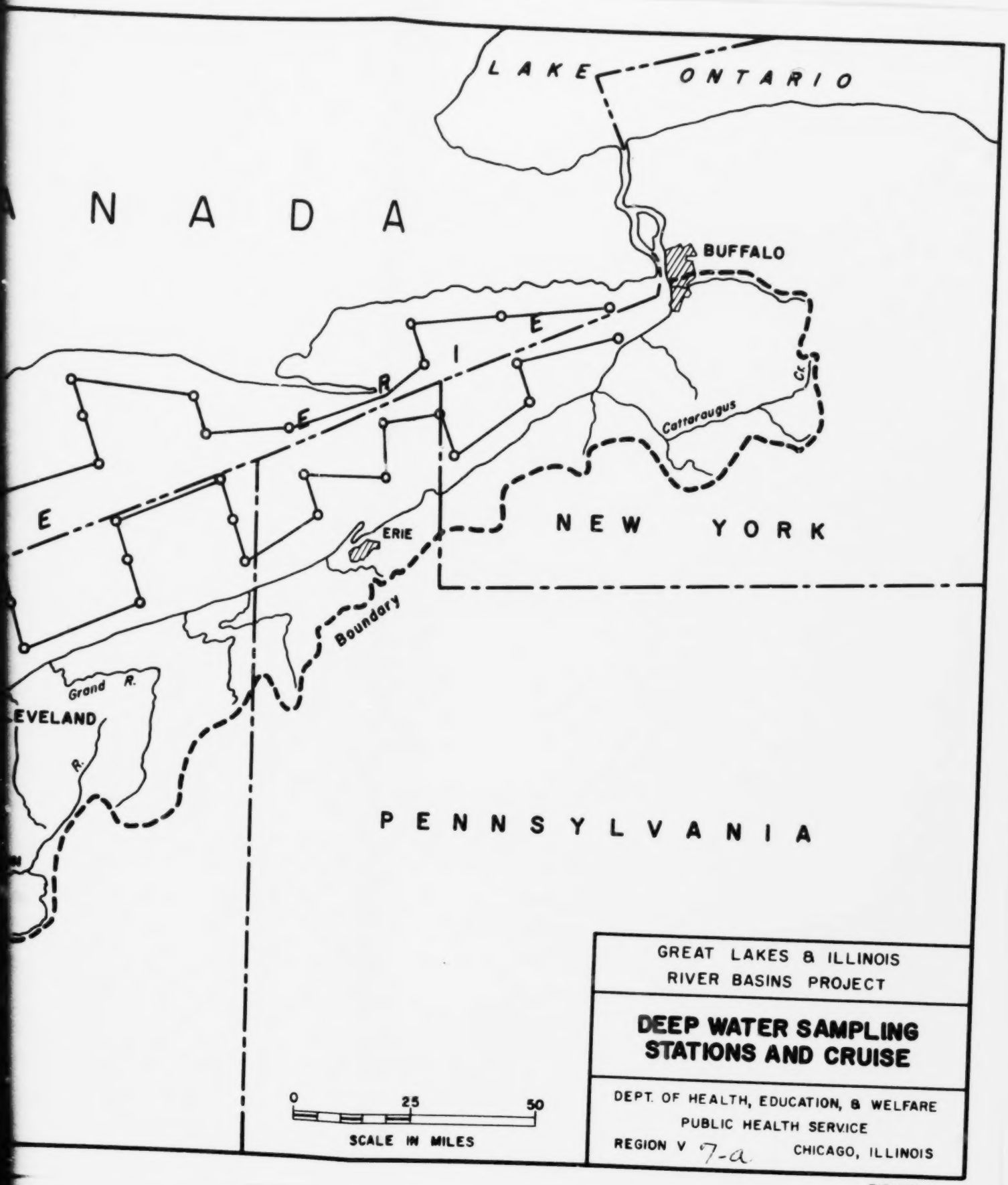
DEEP WATER SAMPLING STATIONS AND CRUISE

DEPT. OF HEALTH, EDUCATION, & WELFA
PUBLIC HEALTH SERVICE
REGION V 7-a CHICAGO, ILLINOI

FIGURE

LAK
HURO
MICHIGAN
DETROIT
LAKE
ST. CLAIR
Huron
River
Raisin
River
River
TOLEDO
River
L
INDIANA
St. Joseph
Maumee
FORT
WAYNE
St. Mary's
R.
Sandusky
R.
Black R.
Watershed
OHIO


LAKE HURON
LAKE
CANADA
DETROIT
LAKE ST. CLAIR
LAKE ERIE
ERIE
Boundary
Grand R.
CLEVELAND
Cuyahoga R.
Black R.
AKRON
Sandusky R.
PENNS
OHIO
0
25
50
SCALE IN MILES


LAKE ONTARIO
NADA
BUFFALO
E
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E
E
Cattaraugus
Cr.
NEW YORK
ERIE
Boundary
Grand R.
EVELAND
R.
PENNSYLVANIA
0
25
50
SCALE IN MILES
GREAT LAKES & ILLINOIS
RIVER BASINS PROJECT
DEEP WATER SAMPLING
STATIONS AND CRUISE
DEPT. OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V 7-a CHICAGO, ILLINOIS

FIGURE 3

The field work and connected office computations could be carried on by the engineers and engineering aides who will also handle hydraulic measurement and instrumentation for stormwater overflow studies as described in another section of the Study Plan.

Lake Currents

Water current studies will be carried out in Lake Erie to determine both the gross circulation and to relate this circulation to wind distribution. Ultimately, it is hoped that wind data from existing meteorological land stations and that supplemented by project investigation can be used to help predict water currents. Knowledge of water currents is essential for predicting transport of pollutants in the lake.

Automatically recording instrument stations will collect water speed, direction and temperature data from several depths for one year and surface wind velocities and temperature for most of a year in the eastern and central basins. The location of these stations is shown in Figure No. 4. Free floating drogues will be used to provide water current information in the western basin which is too shallow to permit the use of automatic current meters. Drogue information will be available for selected daylight periods, each several hours in length, whereas metered current information will be available on a round the clock basis.

Meteorology

Studies to determine wind, temperature, heat energy and humidity profiles over Lake Erie and the surrounding area will be instituted. The study would be made primarily to develop an estimate of the total evaporation from the lake water surface for one year by monthly increments, and to develop techniques for estimating evaporation routinely from any or all of the Great Lakes from standard meteorological data.

An estimate of evaporation will be required for the water budget study to determine the net movement of water into and out of the lake. Wind stress data collected in the study will also be needed in the determination of relationships between winds over the lake and water currents within the lake.

This proposal will require specially instrumented towers for data gathering.

MICHIGAN
DETROIT
LAKE ST CLAIR
Huron River
Raisin River
River
NO METERS (TOO SHALLOW)
TOLEDO
River
INDIANA
St. Joseph
Maumee
FORT WAYNE
St Mary's
Sandusky
Watershed
OHIO

GPO 829379

LAKE HURON
LAKE
CANADA
DIT
LAKE ST. CLAIR
ANTICIPATED
CANADIAN
PATTERN
PATTERN
PROPOSED
U. S.
LAKE ERIE
ERIE
NEW
Boundary
Grand R.
CLEVELAND
Cuyahoga R.
Black R.
AKRON
PENNSYL
HIO
0
25
50
SCALE IN MILES

LAKE ONTARIO
NADA
BUFFALO
ERIE
PATTERN
PATTERN
ERIE
NEW YORK
Cattaraugus
Cr.
U.S.
Boundary
Grand R.
ELAND
PENNSYLVANIA
0
25
50
SCALE IN MILES
GREAT LAKES & ILLINOIS
RIVER BASINS PROJECT
CURRENT METER LOCATIONS
DEPT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION V 8-a CHICAGO, ILLINOIS

FIGURE 4

Special Studies

In order to adequately evaluate water quality conditions in the study area, to establish the significant sources of pollution and to permit the development of a program designed to improve or protect existing water quality the following special studies have been included in the study plan.

Reconnaissance

A reconnaissance of the river system and lake ranges should be carried out before the project proper is instituted. This preliminary survey would determine the feasibility of the ranges to be sampled and would work out some of the factors which would unduly delay a larger scale study. Travel times and various routes of travel could be verified and it would provide valuable data for planning the larger survey. The extent and nature of the work could be laid out and sampling on a scale that could be done by one or two laboratories would be undertaken. Bacterial dilutions and laboratory schedules would be test run. Surveys would be made to determine the water quality profile in regard to time, both under dry weather and storm conditions.

Carbon Filter Studies

In a study of this type it is necessary to determine trace quantities of organic pollutants that are present in such quantities as to be undetected by methods other than the carbon filter technique. Carbon filter stations should be located at tributary sites and at such places along the watercourse as would be subject to changing conditions or organic loading. No valid and firm stationing of the carbon filter stations can be made without an on-site survey; however, the following locations should be considered in selecting sites for carbon filter units:

Raisin River
Maumee River
Black River
Cuyahoga River
Buffalo River
Selected water intakes
Lake Erie

Storm Water Overflows

The pollutional load from combined sanitary and storm water sewers in Cleveland, Toledo and other Lake Erie cities is a major problem. This problem defies any easy economical solution. The effect and magnitude of this type of pollutional loading is difficult to assess because of the great variety of storms and runoff conditions. An extensive investigation of combined sewer overflows should be included in the study. Such an investigation would include both analysis of combined sewer overflows and the impact of such overflows on the receiving body of water.

This study would involve instrumentation of selected areas of the cities with gaging facilities to measure the diverted sewage and the raw sewage before diversion. The quantity and quality of the discharge to the lakes and/or river can thus be evaluated for a specific storm. Extrapolation from one type of storm and runoff area to include a whole metropolitan area is risky. Similar storms should produce a like pattern; however, storms of other intensities and durations would be apt to produce a pollutional profile which could be vastly different. Sufficient storms should be observed to permit developing a nest of curves which would be of considerable value in predicting spillage from various storm patterns which would be used in evaluating the impact of future combined sewer losses on receiving waters.

Bacteriological Studies

In addition to using the indicator organisms to determine bacteriological water quality, a study will be undertaken to determine the presence of pathogenic forms.

The quantity of pathogenic forms passed from the consolidated population of a large metropolis through domestic wastes into the sewers, streams and lakes adjacent to the region should without doubt be considered in a Public Health survey attempting to assay the quality of public waters subject to consumption and personal contact, either accidental, or recreational. In considering the elimination or reduction of pathogenic forms (enteroviruses, amoebic cysts, eggs of parasitic worms, such as roundworms, tapeworms, hookworms, Ascaris, and Shistosoma, known to survive normal disinfection practices,) certain authorities have suggested leaving the burden of disinfection on the water treatment plant. Such a suggestion ignores all other public health ramifications where highly concentrated populations have

contact with polluted water at times, virus-laden, or loaded with tuberculosis organisms (from sanatoria), or parasitic forms. It is, therefore recommended that special attention in the form of pathogenic and parasitological testing be undertaken at sites known to be adjacent to outfalls of either raw or treated sewage. Techniques in the detection of viruses in sewage appear to be far enough advanced to warrant their application in survey work.

While many pathogenic forms have been detected in various waters, and since it would not be feasible to undertake survey testing for all such possible entities, it is felt that work devoted to the detection of entero viruses, Salmonella and the tuberculosis organism, and certain parasitological forms would be both practical and of a definite contribution in gaining information as to the relative safety of the waters in question. The three factors of (1) the rather sudden increase in population of large metropolitan areas plus (2) the increases in migration of population from southern climates (U. S. southern states, Mexico, Puerto Rico) and (3) increased world travel all contribute to the dissemination of pathogenic entities not indigenous to the area.

However, each of these areas of micro-biological investigation are so specialized that special provisions would have to be made to accommodate those areas of activity. Either samples could be submitted to centers devoted to each of these lines of investigation (viral, enteric, tuberculosis, and parasitological' or appropriate specialists might be contracted for a short term (such as academic personnel or summer leave).

Sludge Studies

Sludge studies other than those that are run by the biological staff will be necessary at points and locations other than at the selected ranges. The movement and redeposition of sludge and silt banks, sand bars, harbor bars, underwater deltas, submerged alluvial fans and obstructions cannot be predicted with any great precision and are subject to seasonal growth or erosion. Unnatural deposits from industrial sources, flocculent materials, silt, sewage solids, storm water grit, and many other substances and materials will contribute to sludge formation of varying types. To locate and measure the depth of these permanent and transient sludge deposits will require instrumentation probably operating on the sonar principle which

will locate both the top and the bottom of the deposits. The depth of these deposits will have to be referenced to some permanent datum. Other supplemental data and sludge samples can be collected by the survey crews assigned to map sludge deposits.

The tributary surveys for sludge deposits are proposed to be made in the Maumee, Sandusky, Black, Cuyahoga, Cattaraugus, Buffalo and Niagara Rivers. At least two of the survey vessels should be equipped with recording echo sounding instruments of considerable precision, such as "EDO" Recording Depth Finders.

Sewage and Industrial Wastes Treatment Plants

An intensive sampling program will be carried out at each of the major sewage treatment plants and industrial wastes treatment plants or points of discharge of untreated industrial wastes. This will involve round-the-clock sampling to determine the cyclical character, strength and volume, of the waste discharge from each of these sources.

LABORATORY PROGRAM

The laboratory program will consist of a study of the water quality in the bulk lake water, intensive study of water quality in inshore, shallow areas adjacent to metropolitan centers, and water quality of tributaries. In each of these study phases, emphasis will be directed to those water quality parameters showing the greatest promise in differentiation of water quality. An example of this would be the reduction in frequency of such tests as BOD on the water mass of the lake. This test would provide little or no valuable data where dispersion and dilution of organic wastes are expected to be high. Similarly, more intensive analysis of phenol concentrations would be carried out in the inshore and tributary studies since this pollutant would be a measure of water quality deterioration more readily traceable to waste discharges.

Biology

Biological investigations in the Lake Erie area will be undertaken with three ultimate objectives:

(1) To evaluate the general biological condition of the lake.

(2) To define local or zonal effects from tributaries and waste discharges.

(3) To provide the biological information required for explanation and interpretation of certain chemical, bacterial and physical data.

(4) To guide the development of water quality control measures that will promote desirable, and inhibit undesirable, aquatic life.

Samples of benthic animals, attached flora, and phytoplankton will be collected at stations selected to coincide with stations where chemical, physical and bacteriological measurements will be made.

A minimum program would involve seasonal studies of the biological parameters as outlined below:

Parameters	Frequency	Collected by	Analyzed by
Phytoplankton	Bi-weekly in streams All samples from lake	Aquatic Samplers	Chicago lab.

Parameters	Frequency	Collected by	Analyzed by
Benthic fauna	May, Aug, Oct.	Biologists	Field Station lab. (assisted by Chgo.)
Attached algae	May, Aug, Oct.	"	Field Station and/ or Chicago
Rooted weeds	July or Aug.	"	" "

Field Station-based biologists would be responsible for tributary work and some of the lake cruises. Chicago-based biologists would also work some of the lake cruises.

In general, sampling by biologists will be made independently of chemical and bacteriological sampling. Biologists require longer times at each sampling site and only sample the site two to four times a year. Two biologists, assisted by a driver or boat operator, will comprise a field team.

Biological studies will be scheduled so that each biologist spends about half his time in the laboratory in the identification and evaluation of materials collected in the field.

Laboratory Procedures

Samples collected from the Lake waters would be screened at the Field Station laboratories, preserved and returned to the GLIRBP laboratory in Chicago. Here they would be processed (micro and macro-examination) for enumeration and identification.

The laboratory analyses will consist of:

(1) Bottom fauna identification and enumeration.

(2) Attached plant life, including algae and fungi, identification and measure of abundance.

(3) Phytoplankton identification and enumeration.

Special projects will include studies on the use of artificial substrata for eutrophication evaluation; chlorophyll densities of the subject waters; diurnal fluctuations of dissolved oxygen, and electrofishing and bioassay as needed.

Chemistry

The bulk of this program will consist of routine sampling of the waters under study. Samples will be delivered to the field laboratory for the analyses which are to be made there. The remainder of the samples will be sent to GLIRBP laboratory in Chicago. An outline is presented segregating the analytical tests to be performed at the field laboratory and at GLIRBP into various groups based on the need for repeated determinations for each parameter under study. A reconnaissance study would be used to establish the basis for selection of stations and the frequency of sampling and analysis of the various parameters.

Field Laboratory Outline

Tests to be run:	Frequency of Test:
pH	All samples collected
Specific Conductivity	All samples collected
DO	All samples collected
Alkalinity	All samples collected
Chloride	All samples collected
BOD	Offshore & Tributary samples
COD	Offshore & Tributary samples
Solids	Offshore & Tributary samples
(a) Dissolved	Offshore & Tributary samples
(b) Suspended	Offshore & Tributary samples
Cyanide	Special samples, waste
Phenols	Each sample at selected stations
Turbidity	Each sample at selected stations

GLIRBP Laboratory Program Outline

Tests to be run:	Frequency of Test:
I. Selected Samples (composites)	
Solids (Dissolved, Suspended)	As composited
Gross Minerals (Na, K, Ca, Mg, Si, SO4, Cl, alk. F.)	As composited
II. Selected Stations	
A. All Samples	
CCE	Special samples
ABS	Each sample collected

B. Selected Samples

Nitrogen (NH_3, Kjeldahl, NO_2 NO_3)	50% of all selected stations
Phosphate	50% of all selected stations
Oil	Special samples as needed

C. Selected Samples (Composites) from Selected Stations

Toxic Metals (Cu, Pb, Zn, Cd, Ad, Se)	Samples collected gross minerals and waste outfalls and further composited
Trace Elements - Spectrographic (Ag, Ba, Fe, Mn, etc)	Samples collected gross minerals and waste outfalls and further composited.

Microbiological Investigations

The objectives of the microbiological investigation will be to determine the present quality of the waters of each lake and its drainage basin through the use of certain parameters which express the sanitary status of the waters investigated and through the use of other parameters which help to express other qualities of the lake. This information will provide information as to points of influx of domestic sewage and the wastes of certain industries, as well as localizing areas of pollution within the lake itself.

Parameters and Tests

The tests listed below will be the chief items comprising the microbiological survey of the lake.

Coliform Tests

1. Total coliform via membrane filter (All samples).
2. Coliform differentiation on selected samples by elevated temperature test (gas production from lactose, at 44.5 - 45.0° in 24 hours).

Fecal Streptococcus Tests

1. Total fecal streptococci via membrane filter using K.F. Agar plates. - Inshore and Tributary samples as indicated by reconnaissance studies.

2. Streptococcus differentiation on selected samples via special fermentation and metabolic tests.

Total Plate Counts

Total plate counts - All Lake samples plus selected Inshore and Tributary samples. Procedure will be membrane filter or special pour plates.

a. 20° C.

b. 35° C.

c. With further special bacteriological identification tests on selected samples.

Pathogen Detection

a. Enteroviruses

b. Salmonella

c. Tuberculosis

d. Other selected tests

Total Coliform

The coliform parameter provides information pertinent to the quality of water and will be one of the most important of the bacteriological tests in a survey of this nature.

Coliform Differentiation

Differentiation of the coliform encountered on selected samples via the elevated temperature test will contribute valuable additional information, particularly in the comparison of coliform of fecal origin only.

Total Fecal Streptococcus

The membrane filter method of choice here reveals the presence of all the members of the enterococcus group consisting of Streptococcus faecalis, S. faecalis variety zymogenes, S. faecalis var. liquefaciens, and S. durans; and also other fecal streptococci originating from humans, fowl, cows, sheep, horses (S. salivarius, S. bovis, S. Equinus, and biotype strains

associated with each of these major species). However, to differentiate which of these groups contribute to a given membrane filter colony count, further physiological and metabolic tests are required. These latter tests involve from 2 to 10 steps, including tube tests and microscopical stains. The extent of these tests for each individual colony selected would necessarily limit their application to selected samples and the objective uses of the data.

Total Plate Counts

When collecting data in a survey of streams and lakes, coliform and fecal streptococcus statistics give only partial information on general water quality. Total plate counts with parallel tests conducted at 20° C and 35° C in conjunction with the tests for fecal indicators provide a more complete bacteriological estimate of water quality. The flora from selected total counts will be identified so that the distribution and occurrence of bacterial species throughout the waters studied may be ascertained.

Pathogenic Studies

In addition to using the indicator organisms to determine bacteriological water quality, a study will be undertaken to determine the presence of pathogenic forms likely to be waterborne.

Each of these areas of pathogenic investigations are so specialized that special provisions must be made to accommodate those areas of activity. Either samples could be submitted to centers devoted to each of these lines of investigation (viral, enteric, tuberculosis, and parasitological) or appropriate specialists might be contracted for a short term (such as academic personnel or summer leave).

Field Procedures

Field procedures will be governed by the necessities related to the proper collection and subsequent processing of microbiological samples.

Where the program permits, samples will be processed immediately aboard laboratory vessels, otherwise samples will be processed in the land-based laboratory, preferably within one hour of collection.

Samples are to be collected at the same stations where chemical, physical and biological tests are to be made.

As much repetitive sampling of the selected stations as the duration of the program permits is recommended, embracing distinct seasonal collections.

Field procedures on each of the Great Lakes will embrace pertinent oceanographic procedures, such as sampling at fixed intervals from the surface, and proper geographical distribution over all of the lake to be included in this study.

Laboratory Procedures

All basic water bacteriology procedures will be conducted with strict adherence to (the current edition) Standard Methods for the Examination of Water and Wastewater, or with procedures as set forth by the Microbiology Department of Taft Sanitary Engineering Center, Cincinnati, Ohio.

Radiochemistry

All samples for radioactivity studies will be sent back to the Great Lakes-Illinois River Basins Project laboratory in Chicago for analysis.

Samples are to be collected at the same stations where chemical, physical and biological tests are to be made. Special samples will be collected when high results are encountered from routine samples. Sewage treatment plant outfalls and waste outfalls will be sampled, particularly where known radioisotope users are involved.

Special biological samples will also be collected for radioactivity determinations. This will include plankton on the lake, bottom samples on the lake and tributaries and filamentous algae on the tributaries.

PLAN FORMULATION

Engineering Analyses

A comprehensive engineering analysis will be made using all data collected by the Lake Erie Study. These analyses will include construction of a mathematical model of Lake Erie and its major tributaries. Short range and long range effects of waste loadings will be determined and water quality management programs formulated.

Where the receiving waters are flowing streams, this analysis will include: (1) identification of sources of waste input to stream, (2) the effectiveness of collection and treatment measures, (3) the stream flows available for assimilation of residual wastes waters and the antecedent quality of the stream flow, and (4) the needs for providing additional dilution water, through storage regulation or diversion, to meet the objectives of the program.

For Lake Erie itself, a different set of problems arises in predicting the fate of pollutants and the effects on lake-water quality. These problems include: (1) a study of the mechanics of the mixing process of the waste waters with lake water, (2) the effective volume of lake water in which mixing will ultimately occur, (3)local effects such as possible short-circuiting of partially diluted waste waters from point of waste input to water supply takeout points, (4) the rate of long-range buildup in concentration of persistent constituents and the equilibrium condition, if any, toward which this concentration is trending, (5) the time required for this equilibrium concentration to reach the critical level set by the water quality objectives - or, alternatively, the maximum growth of population and industrial activity that could be sustained without puncturing the ceiling set by those objectives.

Knowledge of lake currents, permanent circulation patterns and effective mixing volumes is essential to the project in order to determine if the critical concentration level might be reached in a local area adjacent to a city water intake long before the average for the whole lake was that high.

Economic and Demographic Studies

It is anticipated that much of the information needed

for the Study Plan will be available in publications of existing agencies and study groups and the collection of necessary data will, in many instances, be a matter of extracting information in existing reports and publications.

With regard to industrial projections, a study of selected industries would be made; these industries would be those which:

(1) Exert major influence in support of growth in economy and population of the area.

(2) Use large quantities of water.

(3) Have significant waste water discharges.

Most of the economic and demographic studies are expected to be obtained through contractual services.

The Economic and Demographic Study would include the following activities: Population studies and projections for each sub-region or other area deemed of value to the study; an economic study of each of the above areas; and an analysis of the rate and direction of population and industrial growth of selected industries through the year 2010.

The following is an outline of the proposed Economic and Demographic Study:

I Population 1930-2010

A. Standard Metropolitan Statistical Areas.
B. County Data
C. Community Data. Selected communities or townships.
D. Service Area. Existing and likely future area.
E. Density of population (persons per square mile).

II Economy of the Area

A. Standard metropolitan statistical areas.

Employment 1950-1960

Total
Manufacturing-total
Selected Industries

Value Added by Manufacture 1939-1947-1957

Total
Selected Industries

B. County Data

Employment 1950-1960

Total
Manufacturing-total
Selected Industries

Value Added by Manufacturer 1939-1947-1957

Total
Selected Industries
Other production measures, e.g., units, tons, When available
Location of Key Plants

C. Major City or Sub-Area

Value Added by Manufacture

III Analysis

Analysis of rate and direction of growth, shift in area or sub-area industry patterns and quantity of production; projection of population and levels of selected industries to 2010.

Special Studies

Special studies planned for the Lake Erie watershed include:

1. Water Oriented Recreation
2. Fish and Wildlife Aspects
3. Agricultural Water Use
4. Water Quality as Related to Land Use Practices

Negotiations will be carried out with qualified agencies on a reimbursible basis for conducting such studies as items 1 and 2.

FIELD STATION ORGANIZATION

The Lake Erie Field Station, located in Cleveland, Ohio, will operate as a branch of the Great Lakes-Illinois River Basins Project. The Field Station Director will be responsible to the GLIRB Project Director, and will be in direct charge of all activities of the Station. (See Organization Chart, Figure 5.)

Certain activities will be conducted from GLIRB Project headquarters in Chicago. These include economic-demographic studies, land use management practices in relation to water quality, and lake current measurements. Contract arrangements will be made through Chicago headquarters for cooperative studies by the Bureau of Outdoor Recreation, and by the Bureau of Sport Fisheries and Wildlife, U. S. Department of the Interior.

Activities in the Detroit Metropolitan Area and environs will be the responsibility of, and directed by, the Director of the Detroit-Lake Erie Project, located at Gross Ile, Michigan. The Lake Erie Field Station Director (Cleveland office) is responsible for coordinating efforts with the Detroit Project to prevent overlap or omissions in the study.

LAKE ERIE STUDY ORGANIZATION CHART

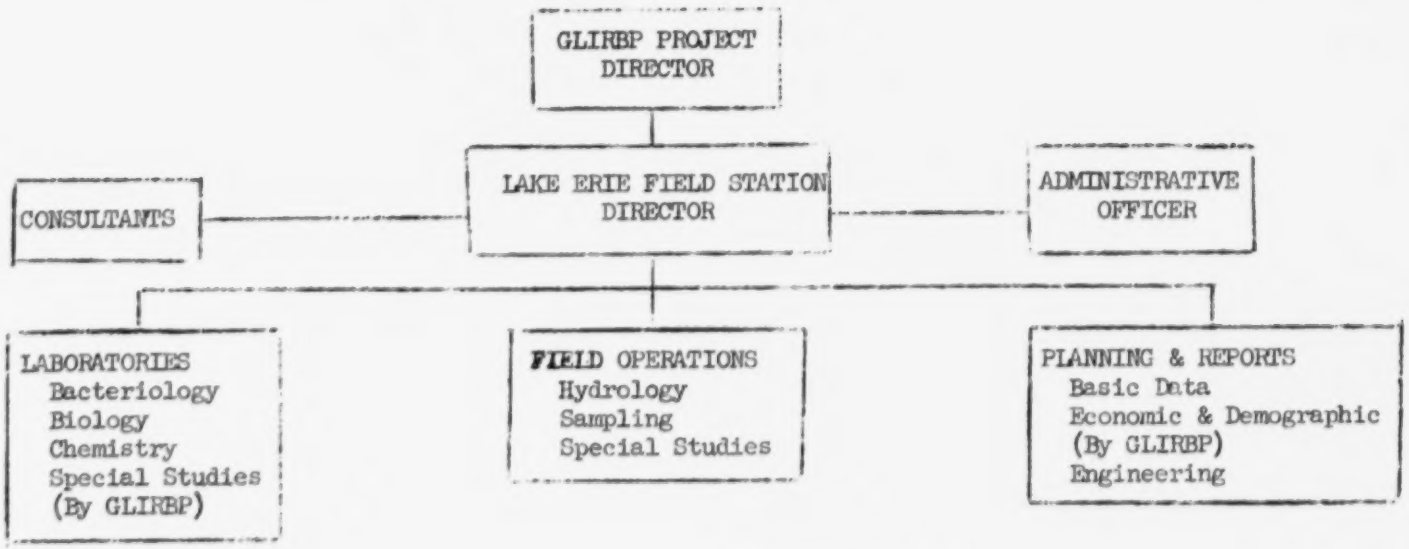

FIGURE 5

TIME SCHEDULE

Figure No. 6 is a bar chart indicating the proposed starting times and duration of the proposed activities including: (1) procurements of personnel and equipment, (2) the setting up of the Cleveland laboratory, and (3) the conductance of field sampling and various special studies.

Preliminary work is to begin in the first half of FY 63 with full scale operations commencing in the first quarter of FY 64 and continuing for one year. The total study period should last approximately two years.

Great Lakes-Illinois River Basins Project
Lake Erie Work Schedule

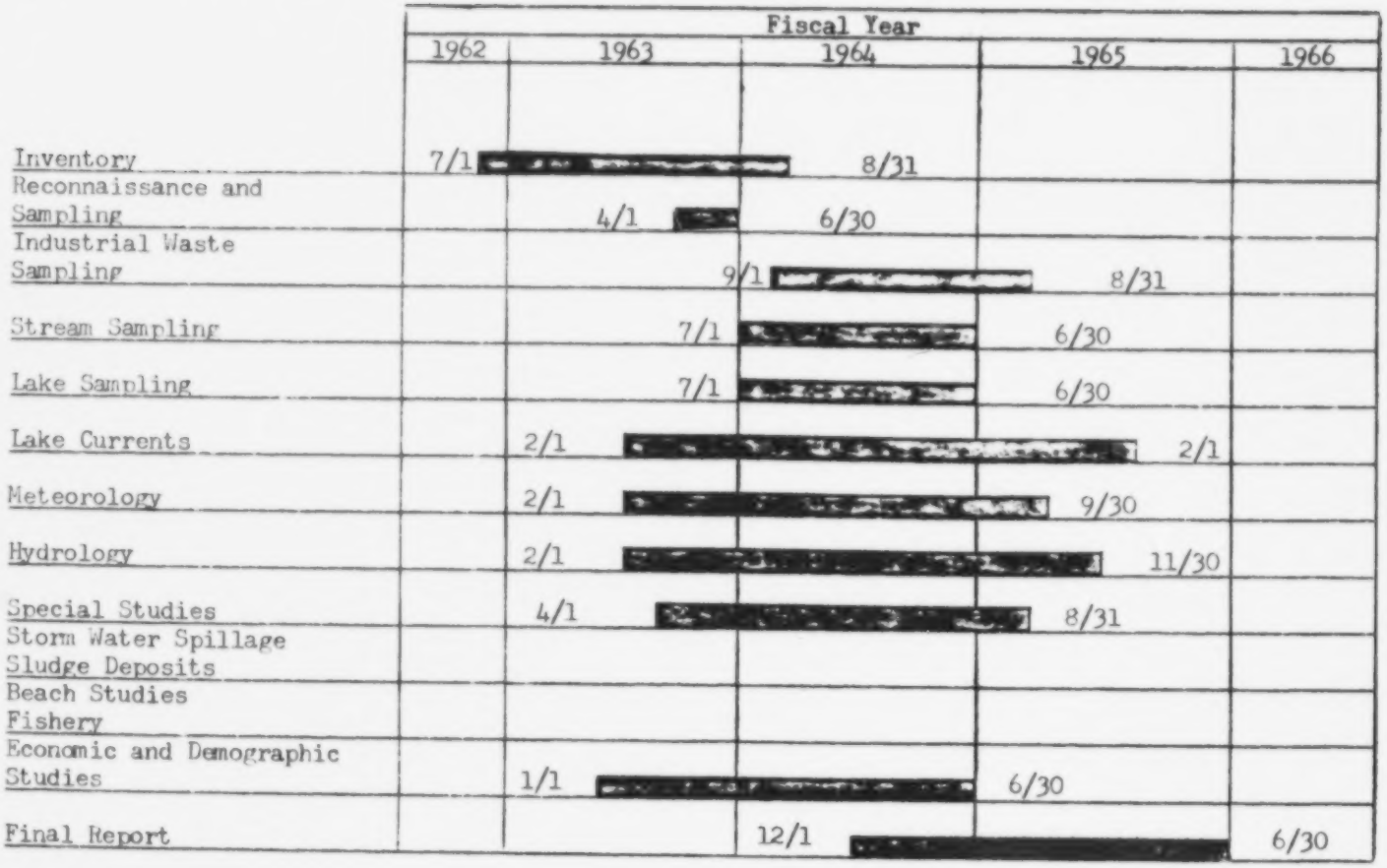

Figure 6

RESEARCH INVENTORY FOR LAKE ERIE

Engineering and Research Data

XXXXXXXXXXXXXXXXXXXXXXXXX
LEG   for greater detail.
X. see the following pages
O. XXXXXXXXXXXXXXXXXXXXXXXXXERESTED
. IN OBTAINING DATA

Row	INSTRUMENTATION AND VEHICLE DEVELOPMENT	TRIBUTARIES AND THEIR DRAINAGE BASINS (RIVERS)	LAKE ERIE	RESEARCH PROJECTS AND DATES	LOCATION (See guide map for code)	ADDITIONAL INFORMATION
[illegible]	X O X O X X O O O X	O X O O O O O X O O O O O O O X	O X O O O X X X O X X O O O O X O O O O O O O O O O O O O X O O O O O X X X	[illegible]	[illegible]	[illegible]
[illegible]	O O X	X X X O O X X X X O	O X X O X O X X O O O O X	[illegible]	[illegible]	[illegible]
[illegible]	X X O O	O X O O O X X X X X X X X O	X O O O X X O O O O X X X O O X X X X X X O X X X O O O O	[illegible]	[illegible]	[illegible]
[illegible]	X O O O X O O	O O O O O O O O	X O O O O X X X O O X X O X X X X O X O X O O	[illegible]	[illegible]	[illegible]
[illegible]	O	O O X	O X X O O O X X O X X X X	X O X X O O O X X X X X X X O O X	[illegible]	[illegible]	[illegible]
[illegible]	O O O O O O O O O	O O O	O O O O X X X O X O O X O O X X X X X O O O O X X	[illegible]	[illegible]	[illegible]
[illegible]		X X X	X X X X X X X X X O O O O O O O O O O O O	[illegible]	[illegible]	[illegible]
[illegible]		X X		[illegible]	[illegible]	[illegible]
[illegible]	X X X O O	O O O O X	X O O O O O O O X X X O O X X X X X X X X X O X X	[illegible]	[illegible]	[illegible]
[illegible]	X O	X X X X O O O X O X	X X O X O X X X	[illegible]		[illegible]
[illegible]		O O X X O	O O O	[illegible]		[illegible]
[illegible]	O X O O O O O O X O O	O O O O O O O O O	O X O O O O X X O O X X X O O O X	[illegible]	[illegible]	[illegible]
[illegible]	X		X X X X X X X X X X X	[illegible]	[illegible]	[illegible]
[illegible]	X		X X X	[illegible]		[illegible]

RESEARCH INV

Engineering and

	INSTRUMENTATION AND VEHICLE DEVELOPMENT											TRIBUTARIES AND THEIR DRAINAGE BASINS										RIVERS																		
	ENGINEERING CONSTRUCTION - MODEL STUDIES	FISHING GEAR	CURRENT MEASUREMENT	RECORDING BUOYS - METEOROLOGICAL	RECORDING BUOYS - LIMNOLOGICAL	FIXED PLATFORMS	WATER SAMPLERS	WATER ANALYSIS TECHNIQUES	METEOROLOGICAL INSTRUMENTATION	EQUIPMENT (TELEMETERING, LOCATION, COMMUNICATION, SOUNDING)	CLIMATOLOGICAL	HYDROMETEOROLOGICAL	SYNOPTIC WEATHER	MICROMETEOROLOGICAL	ATMOSPHERIC CONSTITUENTS	SOLAR RADIATION	NET RADIATION	UPPER AIR SOUNDINGS	WEATHER RADAR	FLOW	TEMPERATURE	OTHER PHYSICAL WATER QUALITIES	CHEMICAL WATER QUALITIES	BACTEROLOGICAL WATER QUALITIES	BOTTOM FAUNA	FISH LIFE	PLANKTON	HYDROLOGY	METEOROLOGICAL DATA WITH BATHYTHERMOGRAPH READINGS	MARINE SYNOPTIC WEATHER	PRECIPITATION (SHIP OR ISLAND)	ATMOSPHERIC CONSTITUENTS	SOLAR RADIATION	NET RADIATION	UPPER AIR SOUNDINGS	MESOSCALE WIND NETWORK	MICROMETEOROLOGICAL
U. S. ARMY CORPS OF ENGINEERS	X	O	X	O	X	X	O	O	O	X	O	X	O			O	O	O	O	X	O	O	O	O	O	O	O	X	O		X		O	O	O	X	X
U. S. WEATHER BUREAU				O	O				X		X	X	X	O	O	X	X	X	X	O									O	X	X	O	X	O	X		
U. S. PUBLIC HEALTH SERVICE GLIBS PROJECT MR. W. G. NEHR, DIRECTOR				X	X			O		O		O		X		O	O		O	X	X	X	X	X	X	X	X	O	X	O	O	O	O			X	X
U. S. BUREAU OF COMMERCIAL FISHERIES		X	O	O	O		X	O		O	O									O	O	O	O		O	O	O		X		O		O	O				
OHIO DEPT. OF NATURAL RESOURCES DIV. OF WILDLIFE		O									O	O								O	X	X	O	O	O	X	X	O	X									
DIV. OF WATER											X									X	X		X					X										
OHIO GEOLOGICAL SURVEY	O		O	O	O	O	O	O	O	O										O			O					O		O								O
OHIO STATE UNIVERSITY NATURAL RESOURCES INSTITUTION																				X	X	X																
GREAT LAKES RESEARCH DIVISION UNIVERSITY OF MICHIGAN DR. D. C. CHANDLER, DIRECTOR																				X	X																	
GREAT LAKES RESEARCH DIVISION UNIVERSITY OF TORONTO DR. G. P. LANGFORD, DIRECTOR			X			X	X		O	O			O			O	O			O	X								X	O			O	O	O		O	O
CANADIAN METEOROLOGICAL SERVICE DR. P. D. McTAGGART-COWAN, DIRECTOR									X	O	X	X	X	X	O	O	X	O	X											X	X	O	X	O	X		X	X
WATER RESOURCES BRANCH, OTTAWA											O	O								X	X							O			O							
ONTARIO DEPARTMENT OF LANDS AND FORESTS	O	X	O	O	O	O	O	X	O	O										O	O	O	O	O	O	O	O	O										
UNIVERSITIES: UNIVERSITY OF WESTERN ONTARIO ASSUMPTION UNIVERSITY OF WINDSOR QUEEN'S UNIVERSITY								X																														
CANADIAN HYDROGRAPHIC SERVICE MR. N. C. GRAY, DOMINION HYDROGRAPHER										X																												

NCL FORM 21 FEB 63 177 (Test)

RESEARCH INVENTORY FOR LAKE ERIE

ering and Research Data

RIES AND THEIR AGE BASINS (RIVERS) — LAKE ERIE

RE	NET RADIATION	UPPER AIR SOUNDINGS	WEATHER RADAR	RIVERS: FLOW	RIVERS: TEMPERATURE	RIVERS: OTHER PHYSICAL WATER QUALITIES	RIVERS: CHEMICAL WATER QUALITIES	RIVERS: BACTERIOLOGICAL WATER QUALITIES	RIVERS: BOTTOM FAUNA	RIVERS: FISH LIFE	RIVERS: PLANKTON	RIVERS: HYDROLOGY	LAKE ERIE: METEOROLOGICAL DATA WITH BATHYTHERMOGRAPH READINGS	MARINE SYNOPTIC WEATHER	PRECIPITATION (SHIP OR ISLAND)	ATMOSPHERIC CONSTITUENTS	SOLAR RADIATION	NET RADIATION	UPPER AIR SOUNDINGS	MESOSCALE WIND NETWORK	MICROMETEOROLOGICAL	AERIAL ICE RECONNAISSANCE	SHIP ICE REPORT	ICE SHORELINE EFFECTS	WAVE MEASUREMENTS	WATER TEMPERATURE TO DEPTH	CURRENT MEASUREMENTS (POINT OBSERVATIONS)	WATER MASS MOVEMENTS (DRIFT DROGUES OR CARDS)	DIFFUSION IN WATER	LAKE LEVELS	PHYSICAL WATER QUALITY
EN WA LA DE	O	O	O	X	O	O	O	O	O	O	O	X	O		X		O	O	O	X	X	X	O	X	X	O	O	O	O	X	O
WEATHER QUANTITAT OF SURGE SATELLIT	X	X	X	O									O	X	X	O	X	O	X			X	O		O			O	O	X	
	O		O	X	X	X	X	X	X	X	X	O	X	O	O	O	O			X	X	O	O	O	O	X	X	X	O	O	X
BOTTOM FAU WATER INTER AREAS; STU AND THE CO				O	O	O	O		O	O	O		X		O		O	O					O			X	X	X	O	O	X
WALLEYE SPAW ULATION IND STATISTICS; (WHITE BASS,				O X	X X	X	O X	O	O	X	X	O X	X												O O	X	X	O	O	O X	X
BOTTOM (APR- WATER CURRE				O			O					O		O								O		O	O	X	X	X	O	X	O
DIATOM ST LOW D. O.				X	X	X																		X		X					X
RELATION				X	X																										
SEDIMENTAT (ECHO SOUN ZOOPLANKTO ENERGY BU	O			O	X								X	O			O	O	O		O	O	O			X	X	X	O	O	X
LAKE-EFFECT MODIFICATI POLLUTION (	X	O	X											X	X	O	X	O	X		X	X									
ST. EVA				X	X							O			O											O				O	
BIOLOGICA WALLEYES, POPULATIO				O	O	O	O	O	O	O	O	O													O	X	O	O	O	O	X
DYE DI RIPPLE ULTI THERM CHIRO																												X	X		
NAVIG																														X	

RE	CHEMICAL WATER QUALITY	BACTERIOLOGICAL WATER QUALITY	BOTTOM FAUNA SAMPLES	FISH LIFE SAMPLES	PLANKTON SAMPLES	COMMERCIAL FISH CATCH	SEDIMENT - SURFACE CONFORMATION	SEDIMENT - TEMPERATURES	SEDIMENT - CHEMISTRY	SEDIMENT - PALAEONTOLOGY	SEDIMENT - DEPTH	SURFACE SEDIMENT SAMPLE	SHALLOW CORES	DEEP CORES	SEISMIC DATA	MAGNETIC FIELD	GRAVITATIONAL FIELD	CRUSTAL MOVEMENT	SEDIMENT - PHYSICAL PROPERTIES & SHORELINE PROCESSES	LAKE DEPTHS
EN WA LA DE	O	O	O	O	O	O	O	O	O	O	O	X	O	O	O	O	O	X	X	X
WEATHER QUANTITAT OF SURGE SATELLIT																				
	X	X	X	X	X	O		X	X		X		O	O					O	O
BOTTOM FAU WATER INTER AREAS; STU AND THE CO	X	O	X	X	X	X		O	X		O	X							O	O
WALLEYE SPAW ULATION IND STATISTICS; (WHITE BASS,	X		X	X	X	X						X								O
BOTTOM (APR- WATER CURRE	O						X	O	O	X	X	X	X	X	O	O	O	O	X	X
DIATOM ST LOW D. O.	X	X	X	X	X	X	O			O	O	O	O	O	O	O	O	O	O	O
RELATION																				
SEDIMENTAT (ECHO SOUN ZOOPLANKTO ENERGY BU	X						X				X	X	X	X	X	X	X	O	X	X
LAKE-EFFECT MODIFICATI POLLUTION (																				
ST. EVA																				
BIOLOGICA WALLEYES, POPULATIO	X	O	O	X	X	X	O		O			O								X
DYE DI RIPPLE ULTI THERM CHIRO	X		X				X		X			X		X						
NAVIG																		X		X

Cleveland 7/20/63

NTORY FOR LAKE ERIE

e s e a r c h D a t a

AKE ERIE

MAP ICE REPORT	TIDE SHORELINE EFFECTS	WAVE MEASUREMENTS	WATER TEMPERATURE TO DEPTH	CURRENT MEASUREMENTS (POINT OBSERVATIONS)	WATER MASS MOVEMENTS (DRIFT BROUGHT OR CARGO)	DIFFUSION IN WATER	LAKE LEVELS	PHYSICAL WATER QUALITY	CHEMICAL WATER QUALITY	BACTERIOLOGICAL WATER QUALITY	BOTTOM FAUNA SAMPLES	FISH LIFE SAMPLES	PLANKTON SAMPLES	COMMERCIAL FISH CATCH	SEDIMENT - SURFACE CONFIGURATION	SEDIMENT - TEMPERATURES	SEDIMENT - CHEMISTRY	SEDIMENT - PALEOMAGNETISM	SEDIMENT - DEPTH	SURFACE SEDIMENT SAMPLE	SHALLOW CORES	DEEP CORES	SEISMIC DATA	MAGNETIC FIELD	GRAVITATIONAL FIELD	CRUSTAL MOVEMENT	SEDIMENT - PHYSICAL PROPERTIES & SHORELINE PROCESSES	LAKE DEPTHS	RESEARCH PROJECTS AND DATES	LOCATION (See guide map for code)	ADDITIONAL INFORMATION
O	X	X	O	O	O	O	X	O	O	O	O	O	O	O	O	O	O	O	O	X	O	O	O	O	O	X	X	X	ENGINEERING STUDIES WATER BUDGET LAKE LEVEL FLUCTUATIONS DEVELOPMENT OF COMPENSATING STRUCTURES	ENTIRE GREAT LAKES DRAINAGE BASIN TO INTERNATIONAL BORDER	DIV. ENGR., NCD, CHICAGO; DIST. ENGR.: BUFFALO, DETROIT, USLS
O		O			O	O	X																						WEATHER RADAR SNOW BAND (BUFFALO); WEATHER RADAR QUANTITATIVE PRECIPITATION (DETROIT); PREDICTION OF SURGES IN LAKE ERIE (WASHINGTON & CHICAGO); SATELLITE PICTURES OF LAKE ICE.	11-16, K, J, I 1-10, M-T P, I, LAKE WIDE	D. LEE HARRIS
O	O	O	X	X	X	O	O	X	X	X	X	X	X	O		X	X		X		O	O					O	O	WATER BUDGET STREAM WATER QUALITY LAKE WATER QUALITY LAKE CIRCULATION LAKE DIFFUSION	P, O, N, M, L, K, J, I, 1, 3, 5, 7, 9, 11, 13, 15	
O			X	X	X	O	O	X	X	O	X	X	X	X		O	X		O	X							O	O	BOTTOM FAUNA & PLANKTON; CHEMICAL EXCHANGE AT MUD-WATER INTERFACE; INDEX STATION SAMPLES; LOW OXYGEN AREAS; STUDY OF FISH POPULATIONS, NATURAL HISTORY, AND THE COMMERCIAL FISHERY.	LAKEWIDE; MAJOR EFFORT IN ZONES 1, 3, 5, 7, 9.	SANDUSKY, OHIO (BASE OF 45-FT. MUSKY II.) JAMES W. MOFFETT
	O	O	X	X	O	O	O	X	X		X	X	X	X						X								O	WALLEYE SPAWNING AREA STUDY (MAR-JUN 63); FISH POPULATION INDEX STUDY (SUMMER-FALL 63); COMMERCIAL CATCH STATISTICS; LOW OXYGEN AREAS, LIFE HISTORY STUDIES (WHITE BASS, CHANNEL CATFISH) (MAR-OCT 63).	1, 3, 5, 7, 9, O	J. U. MANZ
O	O	O	X	X	X	O	X	O	O						X	O	O	X	X	X	X	X	O	O	O	O	X	X	BOTTOM SURFACE & SUBSURFACE STUDIES (APR-SEP 63); WATER MOVEMENT & TEMPERATURE (APR-SEP 63); CURRENTS IN SPAWNING AREAS (APR 63)	1, 7, 9 1, 3, 7, 9 1, 3	R. P. HARTLEY
X			X					X	X	X	X	X	X	X	O			O	O	O	O	O	O	O	O	O	O	O	DIATOM STUDIES; LIMNOLOGICAL STUDIES; EFFECT OF LOW D. O. ON FISH	1, 2, 3, 4	DR. C. E. TAFT DR. N. W. BRITT C. I. RANDLES T. H. LANGLOIS DR. H. PINCUS
																													RELATION OF FLOTSAM TO CURRENTS IN LAKE ST. CLAIR	AREA S	DR. JOHN C. AYERS
		X	X	X	O	O	X	X						X				X	X	X	X	X	X	X	O	X	X	SEDIMENTATION; STRUCTURAL & HISTORICAL GEOLOGY (ECHO SOUNDING 63); OBSERVATION TOWERS; ZOOPLANKTON; CURRENTS & WATER MASSES; ENERGY BUDGET.	LAKE WIDE	R. E. DEANE, G. WEDT (TORONTO); R. R. LANGFORD G. K. ROGERS, (GREAT LAKES I.)
																													LAKE-EFFECT STORMS (63-64); ENERGY BUDGET; CLIMATE MODIFICATION; LAND-LAKE TRANSITION (PROPOSED); AIR POLLUTION (PROPOSED); WIND FIELD & SET-UP (64).		T. L. RICHARDS
		O				O																							ST. CLAIR-DETROIT RIVER FLOWS; EVAPOTRANSPIRATION; WATER BUDGET		F. I. MORTON
	O	X	O	O	O	O	X	X	O	O	X	X	X	O		O			O									X	BIOLOGICAL RESEARCH: FISHERIES (PERCH, SMELT, WALLEYES, BLUE PIKE); DISTRIBUTION; MOVEMENTS; POPULATIONS. (SINCE 1955).	WHOLE LAKE PLUS LAKE ST. CLAIR (MAINLY CENTRAL & EASTERN BASINS)	FISHERIES BIOLOGIST, LAKE ERIE FISHERIES RESEARCH UNIT, DR. RG FERGUSON
				X	X				X					X		X				X		X							DYE DIFFUSION STUDIES (MAY-SEP 63); RIPPLE MARKS, PHOSPHATE SEDIMENTATION, [illegible] PROBE ANALYZER; THERMAL HISTORY OF LAKE ERIE (MAR 63); CHIRONOMIDS (APR 63-TO ABOUT 1965).	WEST END OF LAKE PORT TALBOT AREA LONG POINT AREA LAKE WIDE	DR. J. R. KRAMER DR. A. E. BECK DR. T.G. CSANADY DR. H. STICH P. H. RUEFFEL
						X																			X		X		NAVIGATION CHARTS; LAKE LEVEL REPORTS		

LEGEND:

X = STUDIES BEING CONDUCTED
O = STUDIES PRESENTLY NOT PLANNED - INTERESTED IN OBTAINING DATA